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LEAF STRUCTURE AND WOUND RESPONSE[1]

THE leaf through its light relation underlies the specializations of vascular plants. As the primary food-making organ its demands explain in large measure the habits and structures of terrestrial vegetation. The radial symmetry about an air-earth axis, the non-motile plant body with its firm cell walls, the habit of indefinite elongation with correlated radial growth, the persistent alternation of generations and sporophyte dominance, and even the complex spore-bearing parts in their interesting array, are logical corollaries to the nutritive independence achieved through photosynthesis.

The foliage leaf, despite its temporary nature, dominates the plant's organization. The stem in final analysis is only a structure for supporting leaves, carrying to them certain raw materials and transporting from them the products of their elaboration. The root likewise is servant to the foliar organ, anchoring the whole mechanism and responsible also for the intake of water and dissolved materials. Flowers, seeds and fruits are the crowning achievements of organisms that must reproduce with limited motion and without locomotion. But the leaf as the energy-binding agent is of primary importance, and without it other parts are helpless and meaningless.

The foliage leaf is necessarily a delicate and exposed organ. Since light must penetrate to its interior tissues, it may not employ the massive coverings which protect larger roots and stems. Nor is its position in any degree protective as is the case with roots which lie buried in soil. The leaf is not only aerial but constitutes the peripheral zone of the shoot system, and becomes therefore the most exposed part of the plant. For most leaves, a single cutinized wall of microscopic thinness constitutes the only barrier between the living protoplasm and the outside world. Auxiliary covering layers are found on many, but these at best are an inefficient substitute for the cork and bark which constitute the buffer tissues for other plant parts.

Leaves are therefore peculiarly liable to injury. Physical forces such as wind or hail often break their

[1] Address of the retiring vice-president and chairman of Section G—Botany—American Association for the Advancement of Science, Philadelphia, Pennsylvania, December 28, 1926.

tissues or beat them to pieces. Fungi and bacteria gaining entrance through stomata, wounds or by penetration through epidermal walls, attack their interior tissues. Insects as adults or larvae are parasitic on practically every kind of green leaf, and cause enormous loss of tissue and foliar efficiency. Countless numbers of grazing animals ranging up to the largest herbivores pasture on foliage in every region of the world. Against all of these there are at best only fragile and passive barriers. Chance alone permits a given leaf, or plant for that matter, to survive.

But it is worth while to recall that leaves, while helpless in any active way to defend themselves, may and do employ numerous devices to lessen the harmfulness of their wounds. It is a matter of daily observation that scarcely a functional foliage leaf can be found without mutilations. One marvels at the relative immunity to traumatic infection which they seem to enjoy. What then are the defenses of the living leaf against the dangers following lesion? More specifically, recalling the porous nature of the mesophyll, what enables the plant to escape desiccation through pathological water loss and increased transpiration due to the direct exposure of delicate cells? With moist living tissues open directly to the outside air, what so successfully prevents infection in such wounded leaves?

For the stem such questions have been answered quite fully. Their responses to wounds and their protective tissues have been widely studied. For similar reason there is a voluminous literature dealing with foliar disturbances leading to gall-formation. Relatively much less attention has been given to the processes of normal cicatrization in foliage leaves. While general references are numerous, the published accounts, particularly those dealing with the development of the cicatrice seem incomplete. The extensive paper by Massart[2] surveys the phenomena of cicatrization in all plant groups and includes three figures illustrating foliar wound response. A few other papers are mentioned below in relation to special topics to be discussed. Such paucity of titles is eloquent of the efficiency of this natural process; had wounded leaves been more of an economic problem through greater liability to infection, their place in literature would have filled volumes. The study of the leaf's defense therefore lacks that human interest associated with dramatic or tragic events. Our narrative is instead the simple and rather prosaic statement of work well done at the proper time—a process, however, which is daily operating to avert disaster from every green plant. For some time I have been interested in trying to analyze the structures formed following foliar lesion. Some observations and conclusions are outlined below.

The capacity of leaves to withstand wounding. Simple preliminary experiments repeated at different times and on many species of woody plants readily illustrate the marked degree of mutilation which leaves may endure (Wylie[3]). By means of a leaf-punch, which cuts out cleanly circles of tissue, it is easily possible to excise any part of the blade without injury to remaining portions. By way of example, experiments show that most leaves get along very well with all their major veins interrupted. Such operation, which would not be liable to occur under natural conditions, throws the entire burden of conduction upon the minor venation which must carry not only the normal load but in addition to this the water lost from wounded margins and open ends of veins. It is worthy of remark also that such leaves usually get along remarkably well mechanically with all larger veins transected.

Much of the blade may be removed without death of remaining tissue. Using such a leaf-punch, numerous circles of lamina were cut out in rapid succession early in the forenoon of clear summer days. The freshly wounded leaf was thus subjected to full traumatic water loss during the period of maximum transpiration. Most leaves met such test without death of tissue unless the cuts were very close together. In some cases, the total extent of wounded margin was five or six times the periphery of the entire blade—a degree of wounding seldom equalled by insect attack and involving probably serious loss of water.

To mention only one other simple experiment,—it is readily possible to test the amount and direction of conduction in the minor venation. Using the leaf-punch, one may partly isolate U or C-shaped areas of blade with isthmus connection in any desired relation. The direction of flow may be thus altered or completely reversed, and by varying the width of the isthmus the gateway is proportionately modified. Results show that our common mesophytic leaves may carry through their minor venation, or islet borders, a conduction overload of several hundred per cent. in addition to the traumatic water loss. The most frequent cause of tissue loss may be attributed to the fact that larger veins proved to be barriers to cross conduction. This may have been due in part to leakage from their open ends.

In brief such experiments reveal an unexpected capacity of the minor venation to carry on greatly increased conduction in any direction and also show

[2] Massart, J., La cicatrisation chez les végétaux. Memoires couronnés de l'Académie royale de Belgique 57: 2–68, 1898.

[3] Wylie, Robert B., Concerning the capacity of foliage leaves to withstand wounding. Proc. Iowa Acad. Sci., 28: 293–304, 1921.

the mechanical efficiency of these slender vascular branches. There is also an obvious corollary in all of the cases that some factor operates quickly to slow down traumatic water loss thus enabling the leaf to tolerate such degrees of wounding.

The preliminary barrier, or pseudocicatrice. Following lesion, with the death and collapse of exposed cells along the wounded edge, a temporary protection is developed which is here called the pseudocicatrice. Slowly beneath this covering the living parts give rise to new layers of cells which in time mature into the true cicatrice. This latter structure varies very greatly, but in thicker leaves may be a compact cork-like tissue with heavy and highly modified cell walls.

Turning first to the pseudocicatrice, it should be noted that this temporary barricade forms quickly following wounding of the leaf. The primary structural constituent of this pseudocicatrice is the collapsed mesophyll tissues. A varying zone, ranging from a few to fifty or more cells in depth, dies as a result of crushing and subsequent desiccation. These dead cells usually collapse in part, but their walls generally enclose air spaces. This mass, firmly anchored to the leaf margin, constitutes the initial and rarely the only apparent protection to the wounded leaf.

A second element of the pseudocicatrice, usually a very important one, results from the behavior of the epidermis. One or both of these layers usually curve inward with the collapse of the interior cells. In many leaves the inturned epidermal layers often meet or may overlap, thus giving the wounded leaf a rounded edge which is covered by these cutinized walls. Even in those forms with heavy cuticle in which the epidermal layers retain their position and protrude outward they still afford considerable protection to the parts beneath and serve to anchor the collapsed mesophyll.

In the third place, certain secretions may add efficiency to this preliminary barricade. Conspicuous here is the latex which, if present, fills interstices, cements the collapsed tissues, and upon drying forms a firm mass. Its distribution may not be uniform along the wounded surface but droplets form at the termini of interrupted veinlets where leakage seems most serious. In this category might also be included resins, slime secretions, gums, and other plastic products, together with modifications of cell walls.

Of the efficiency of the pseudocicatrice promptly to check water loss, there can be no doubt. In all experiments noted above, where leaves were severely wounded and in various ways, the advance of drying was soon checked. It was noted that even on very hot and dry days the area of abandoned tissue, dying or dead, was delimited within four or five hours, and there was usually little subsequent shifting of the boundary line. In spite of the great extent of freshly exposed margin in certain of these experiments, the barriers were set up quickly and functioned efficiently both as regards water loss and in preventing infection. In studies of perhaps thousands of sections of wounded leaves from varying habitats in different zones, there was revealed a striking absence of extraneous organisms. The only case noted was the occurrence of yeasts in the pseudocicatrice of certain New Zealand thick-leaved evergreens. In spite of the fact that the leaf is wounded far more frequently and more seriously than any other plant part, it seems to adjust itself promptly if external conditions are favorable for the formation of the pseudocicatrice. Difficulties are presented of course when the invading organism is carried by the biting insect.

A further function of the pseudocicatrice is its possible stimulation of underlying tissues to the development of the cicatrice proper. In wounded stems the crushed or dying cells seem to release substances which stimulate the formation of wound cork. One recalls in this connection the publication by Haberlandt[4] in which he holds that his experiments show such hormones operate as well in the instance of wounded leaves. If so, the development of the pseudocicatrice may be causal or at least is concurrent with the formation of such possible stimulating substances. Certain results from the study of wounded leaves of *Prunus Laurocerasus* by Blackman and Matthaei[5] are of interest. They found that if the leaves were cut with a sharp razor the wounded margin did not exhibit the usual wound reaction while those wounded with crushing of tissue were stimulated to cell division. In their experiments, it should be added, the leaves were severed from the tree and were kept in a moist chamber. Woit[6] has recently stated that freshly wounded leaves in moister air respond by callose growths while in drier air they form wound cork. In my experiments parallel series, wounded with razor and with scissors respectively, and left on the tree showed no essential difference in the healing tissues developed. The dying or the drying of these marginal cells seems to be tied up with conditions at any rate leading to the development of the major protective tissue within.

[4] Haberlandt, G., Wundhormonene as Erreger von Zellteilung. Gebrüder Borntraeger, Berlin, 1921.

[5] Blackman, F. F., and Gabrielle L. C. Matthaei, On the reaction of leaves to traumatic stimulation. Ann. Bot., 15: 533–546, 1901.

[6] Woit, M., Über Wundreaktionen an Blättern und den Anatomischen Bau der Blattminen. Mitt. Dtsch. Dedrol. Ges. 35: 166–187, 1925.

The cicatrice proper. The true cicatrice, which is discussed very briefly in this paper, starts leisurely and develops slowly. Mitoses rarely occur within twenty-four hours after wounding and may not be evident for several days. In thinner mesophytic leaves the cicatrice is complete in about ten days, while thicker and especially the more xerophytic forms require up to twenty days for its completion.

The earlier cells to enter into activity are those of the mesophyll. The irregular cells back of the pseudocicatrice enlarge and soon divide with walls laid down parallel to the wounded edge. By further division and enlargement a compact tissue is formed which closes the air spaces in this zone of the leaf. The palisade cells if greatly elongated usually divide by cross walls. In *Rhus glabra,* for instance, the very long palisade cells often divide into several shorter cells before vertical walls appear. There is of course great variation in these events of cell formation depending on the type of leaf, the shape of cells and their relations to veins and border parenchyma.

It was with considerable interest that the behavior of the epidermal layers was watched in the region of the developing cicatrice. These highly-specialized cells responded by prompt mitoses usually by vertical walls only. Even the very thick-walled and heavily cutinized epidermal cells of the sclerophyllous evergreen type entered regularly into division. Indeed, among such, divisions of these cells are carried much farther than in simpler leaves. In some instances as many as a dozen cells were obviously the progeny of a single epidermal cell. In brief, all cell layers of the leaf blade share in the work of building the new protective tissue. The cicatrice proper is a unified structure which generally shows greater uniformity of cell form, size and content than the several leaf layers which have through mitoses contributed to its formation.

A second phase which of course intergrades with the one just mentioned is that of cell enlargement. The living cells, new or old, which function in the development of the barrier across the wounded surface usually undergo enlargement. The outer cell layers of the cicatrice usually enlarge most, due in part no doubt to the reduced pressure on that surface. The cells of this region are often gibbous on the external face where not opposed by turgid cells. In general, the thinner the leaf the simpler the cicatrice and the greater the irregularity of its cells. While thicker leaves may develop a much more extensive cicatrice this will have a regular cork-like cell arrangement and show less enlargement. A simple leaf like *Vitis* has few and much distorted cicatrice cells, while massive leaves such as those of *Pseudopanax* have extensive development of wound cork. A common factor whatever the form of the cells is their compactness without intercellular spaces between.

A third epoch involves modifications of the cell walls. These are always thickened and often with secondary lamellae of marked development. The cells of the inner border may present the appearance common in epidermal cells of having only their outer walls markedly thickened. Most cells of the cicatrice, however, cease their activity and function mechanically as dead cells, as in normal cork tissue. (Wylie.[7])

Cell walls in the cicatrice tissues are usually modified chemically. The earliest change noted was the presence of lignin behind the wounded margins. This region responds positively to the phloroglucin test as early as twenty-four hours after wounding. The true cicatrice develops lignin early and long after maturity its cells show the same reaction. Lignin, therefore, appears early and is usually permanently associated with the cicatrice cells. The common presence of suberin in the walls of the mature cicatrice was also established. Wyneken[8] who made a survey of a number of species reported that suberin was found in the outerlayers of cicatrice in all dicotyledons examined.

In general, and in conclusion, it may be affirmed that the leaf by virtue of its morphology is peculiarly well fitted to deal successfully with its wounds. The thinness of the lamina automatically limits the breadth of exposed tissue following lesion. The mesophyll is so delicate and thin walled that a zone of its tissue quickly collapses padding the exposed edge. Meanwhile the incurving or projecting epidermal layers afford an important measure of protection. These together with any secretions formed constitute the pseudocicatrice which renders first aid and allows time for the development of the specialized barrier, or cicatrice proper, with its compact tissues and highly modified cell walls. In their finished form these structures, the cicatrice and pseudocicatrice, are well qualified to protect the leaf margin. In a short time they convert an open wound into the most heavily barricaded part of the leaf's surface.[9]

Robert B. Wylie

University of Iowa

[7] Wylie, Robert B., Some wound responses of foliage leaves. Proc. Iowa Acad. Sci. 29: 238–244, 1922.

[8] Wyneken, K., Zur Kentnis der Wundheilung an Blättern. Inaugural-Dissertation, Göttingen, 1908.

[9] A grant from the American Association for the Advancement of Science in 1925 aided in the collection of Pacific coast material helpful in the preparation of this paper.

FACTORS OF SIGNIFICANCE IN THE DEVELOPMENT OF EUROPEAN AGRICULTURE[1]

THE unmistakable signs of recovery in evidence in most of the European countries encourage the hope that normal conditions and relations will be reestablished within a very few years. It is not to be expected that all these will reflect the situation as it existed before the war. There has been too much change in political boundaries and alignments to permit the return to the exact pre-war agricultural conditions. There have been important social as well as economic changes which, in their turn, are certain to react on the future progress of European agriculture.

Even a cursory study of trends and tendencies in European farming will readily emphasize the importance of certain factors. Among these we should note land and its uses, crops and crop areas, live stock and crop protection. The preparation of more finished agricultural commodities from crop and live stock products must also be included among the major factors. Likewise, we must give heed to cooperation, taxation and tariffs, transportation, markets, research and education and social rural organization.

Many of the large land holdings have been divided and are still being divided into smaller units. Generations of experience and the shifting currents of economic and social life led to the acceptance of large farms as a vital part in the agriculture of European countries. The large estates both in western and eastern Europe were, on the whole, well managed. A number of them were, in fact, experiment stations where intelligent direction was being given to methods of soil improvement, the use of chemical fertilizers, the selection and breeding of superior types of plants and animals and the use of labor-saving devices. The social consciousness which the Armistice brought to many people in Europe soon made itself felt in the demand for a more equitable distribution of the land. Rising taxes, increasing labor costs and legislation not always free from bias has forced and is still forcing the subdivision of the larger estates. The new owners of the smaller units are not always well enough provided with working capital and with the business skill and forethought to allow them to obtain the same returns per acre that were easily secured by the former owners. There is, no doubt, a distinct social gain in the restoration of much of the land to the peasantry and to the landless classes who are anxious to live on the land. There is an undoubted economic loss because of the lessened effectiveness with which the smaller units of land are being used. But whatever the merits of the case, one must accept the situation as it is and must anticipate the development of a greater degree of cohesiveness among the owners of the smaller areas in order that suitable organization and cooperation might offset the disadvantages that are inherent in smaller holdings.

Much thought is being given in Europe to land problems both as to national policies of land ownership as well as to the financing of agricultural enterprises. Not the least suggestive of the recent publications on land problems in Europe is the report of the British Liberal Land Committee. This report is not only full of interesting facts and figures, but it also attempts to develop a philosophy of land ownership and use that may have a far reaching effect. It is argued by the authors of the report that the title of the land is vested in the state and that this has never been alienated nor should it be alienated for the good of the nation as a whole. It is argued further that the possessor of the land should be allowed to remain undisturbed in his possession as long as he uses the land properly and performs his duty to the nation fully by protecting the soil against deterioration and exacting from it sufficiently high returns.

The redistribution of the land as it has occurred both in western and eastern Europe has created many new problems in taxation, housing, transportation, schooling, etc. It has raised questions which are still to be answered as to production levels, crop rotations, the maintenance of live stock, forestry problems, and the standards of living in the rural home. Other questions have come to the fore because of the adjustment in land holdings, and have made necessary much new legislation. Land hunger is being reflected not alone in the subdivision of the larger holdings, but also in the reclamation of areas formerly regarded as of little promise for crop production. The natural development in the use of the land would leave to the last soils that are very sandy and possess a slight water-holding power. It would also ignore very heavy tenacious clay soils whose drainage becomes difficult. Similarly, peat soils whose water table is quite near the surface would also be regarded as very costly to reclaim. But the pressure for land will sooner or later compel the reclamation of such areas. In fact, we find this condition to exist in western Europe, particularly in Denmark, Germany, Italy and elsewhere. By bringing under cultivation areas not hitherto used for agricultural purposes the need for imported food may be made less acute for a time at least. More effective methods of soil treatment,

[1] Address delivered at the annual dinner of Section O—Agriculture—and Affiliated Societies at the Philadelphia meeting of the Association for the Advancement of Science. It was given in lieu of the address of the retiring vice-president, Professor Charles V. Piper, who died earlier in the year.

particularly in the use of chemical fertilizers, is also aimed toward the same end.

Crops and Live Stock

A comparison of crop yields of pre-war and post-war periods will show that there is a definite tendency toward the reestablishment of pre-war production. Nevertheless, the production of wheat is still smaller in volume in nearly all the European countries than it was prior to 1914. There has been a very marked falling off in the production of rye. It is claimed by European economists that the populations of western Europe are showing a more decided preference for wheat bread than they did in pre-war periods. It would seem, therefore, that the relative shrinkage in the area devoted to the production of rye represents a more or less permanent feature of cereal farming in Europe. Other crops like barley, oats and flax have not yet reached pre-war levels when total yields are considered. On the other hand, crops like potatoes and sugar beets have shown a more marked return to former yields. In some of the European countries the yields of potatoes are even now greater than they were before 1914. It would be but natural to expect that with the increase in the number of small holdings the owners should devote themselves to the growing of crops which would produce a larger quantity of human food per acre. Potatoes, sugar beets and miscellaneous vegetables lend themselves more readily than do cereals to the maintenance of a relatively large population on any given area. With the wider use of chemical fertilizers, particularly of the cheapening of nitrogenous fertilizers, we should expect an intensification in the production of crops and higher production levels at least in western Europe. Ultimately, higher levels of production will become manifest also in eastern Europe.

But, with the development of more intensive methods of soil treatment, there must come also other adjustments. The carrying capacity of pastures, the more systematic growing of soiling crops, the importation of concentrates, the housing of the animals and the production and marketing of live stock products are certain to be a notable factor in the agricultural progress of Europe in the next decade. Already we see a marked increase in the number of dairy animals, an increase far in excess of pre-war numbers in some of the European countries. This is also true of poultry. On the other hand, sheep and beef cattle are holding their own in but few places, and swine are far from having regained their pre-war importance. There is a marked tendency to develop better types of live stock in order that there might be a greater production of milk, mutton, veal, pork, eggs, etc., per animal unit.

Plant and Animal Protection

The toll levied by fungi, bacteria and other micro-organisms is at all times quite heavy. Methods of plant protection in vogue in pre-war days were but partly effective. There is evident now a more determined effort to lessen the losses due to blights, mildews, rusts and other afflictions of cultivated crops. The seed treatment with organic mercury compounds, the use of fungicidal dusts and sprays is becoming more wide-spread. In the same way more serious thought is being given to measures for lessening the damage done by economic insects. However, the ravages of plant diseases and of insects are very costly to European farmers. The same may also be said of certain diseases of live stock. Foot and mouth disease is exceedingly annoying as well as costly. Anthrax, tuberculosis, pleuropneumonia, foot rot among sheep, intestinal parasites of all sorts are reducing production in a serious way. The flocks and the herds are increasing again in size. Even in Russia one finds a striking increase in the number of farm animals. The assumption is justified that a more concentrated effort is near at hand toward the combatting of the very large losses occasioned by the present inadequate protection of crops and animals.

Other Significant Tendencies

The proper distribution of labor has always been a serious problem in European farming. The large estates managed to find employment for many men and women both in the forests and in the manufacturing enterprises that are dependent on agricultural raw materials for their success. The subdivision of the large estates has created new problems by way of employment. European governments are face to face with rather serious questions. In some measure these are being answered by the initiation of the programs of land reclamation, road building, forest planting, etc. Taking past experience as a guide, we must assume that cooperation among the smaller producers will have the effect that it has had in Denmark, providing employment for farmers when they are not actually engaged in planting, tilling or harvesting their crops. Dairy establishments, nurseries, canning factories, tanneries and many other industries of a rural and semi-rural character are coming to play a significant rôle in European agriculture.

If time permitted, I might refer in some detail to other factors that seem to stand out as of great significance. Cooperation has been mentioned in passing, but the day of cooperation in European agriculture, and for that matter in the agriculture of other countries, has just begun. The factor of taxation is one of major importance, no doubt. All the European governments are struggling with the question of

equitable distribution of tax burdens. To what extent agriculture may be properly asked to bear a larger or smaller part of the tax burden is an unanswered question in most of the European countries. We do know that tariffs are, in a number of instances, used to protect or virtually to subsidize domestic production of food. The industrial elements in the population are naturally inclined to protest against high tariffs on agricultural commodities, for these tend to increase the cost of living. Both the employers and employees of the industries recognize this fact.

The transportation of agricultural commodities is passing through rather interesting readjustments. Despite the high cost of motor fuel, transportation by truck is, in a measure, doing for European farmers what it has done for farmers in the United States. Gradually but steadily the average distance between producer and consumer is growing longer. There is less intimate contact than there has been between the farmer and the purchaser of his products. The services of the middleman must, of necessity, become relatively more important as the distance between the producer and consumer is increased. We must likewise consider roads, freight rates, storage and local distribution as a part of the modern program of agricultural marketing.

Finally, we may note that agricultural research in Europe as well as agricultural education are very much out of keeping with the needs of a progressive agriculture. With few notable exceptions, agricultural research in Europe is supported in a niggardly way. Moreover, the experiment stations have not the intimate contact with the farmers that the American experiment stations have developed. The level of education among the owners of large farms is high enough. On the other hand, the level of education among the small farmers is again, with some notable examples, too low to permit of the most effective use of inventions and discoveries. European governments are obviously aware of this fact but very often find themselves unable to apply the remedy because of lack of financial resources. In some instances greater resources for agricultural research and education could be made available if the political leaders could be made to realize that the support of agricultural schools, colleges and experiment stations is justified in the returns which sooner or later come because of more efficient production, greater contentment, higher economic levels and better social relations in the rural communities.

JACOB G. LIPMAN

NEW JERSEY AGRICULTURAL EXPERIMENT STATION

FRENCH INSTRUCTION AND RESEARCH IN BIOLOGY

THE young Frenchman comes to the university with a mature mind, well drilled in the fundamentals of general culture and with a set purpose to his studies. The "Baccalauréat," which he has just completed, is equivalent to the first two years' work in an American university of the highest grade, and to the bachelor's degree from a smaller American college. Biology, then, is taught in France not so much with the purpose of giving a general idea of the subject to great numbers of students, as with the view of training intensively a few young men and women as biologists or teachers of biology.

The "Licence," which is the first university title to be acquired by a student after the "Baccalauréat," is composed of three "Certificats" in as many subjects. For prospective teachers of biology in the Lycées, these "Certificats" must be in zoology, botany and geology. For future biologists, additional "Certificats" in chemistry, physiology and physics are recommended. The student in biology also usually spends some time, before his "Licence," at one of the several marine biological stations, where he studies marine invertebrates, and where he comes in close contact with research workers in biology from all over the world.

A "Certificat" consists of the combined teaching of two or three professors in the same subject. The full professors give only lectures on special subjects; the "Maîtres de Conférences," corresponding to the American associate professors, cover an entire subject during the year. Thus, during the academic year 1925–1926 in Paris, M. Paul Wintrebert, professor of comparative anatomy and histology, gave a series of lectures on the vertebrate skeleton, while M. François Picart, maître de conférences in embryology, covered the whole field of invertebrate and vertebrate embryology. The instructors do, on the whole, very little formal teaching, and the student is expected and even required to glean for himself out of text-books whatever of importance in a subject is not taken up by the professor or maître de conférences. He is liable to be examined on any part of his subject in the series of examinations which occur at the end of the academic year. While the laboratory work, which is in the hands of a "chef de trauvaux" or a "préparateur," is compulsory, attendance at any of the lectures is not required, and no examinations are usually given during the year.

If, at the end of his "Licence" the young biologist wishes to work either for a "diplôme d'études supérieures" or for a doctorate, both of which imply original research work, he chooses the laboratory in which he wishes to carry on his investigation, and

familiarizes himself of his own accord with the required technique. His relations to his professor now become those of an apprentice to his master, but the greatest latitude is given to him to work as he best sees fit. There are no special courses to be followed nor hours to be spent in the laboratory. Students who are working for the "diplôme d'études supérieures," which is required for teaching in a lycée, are usually given a research subject; those who have a doctorate in view search out a subject for themselves, or, if they ask suggestions from the professor, are quite free to work out the problem according to their own lights. Such a system is of course not fit for the mass production of doctors, but is excellent for the careful training of a few specially gifted individuals.

The Parisian laboratories, placed in a great center of intellectual life, and usually with more funds to dispose of than the provincial laboratories, are the ones which are most likely to attract foreign investigators. It may thus not be amiss to lay particular stress on the enumeration and description of the laboratories in the capital.

Zoology is taught in five laboratories at the Sorbonne, at the Êcole Normale Supérieure and at the Êcole de Pharmacie. The premedical students attend special courses, which while given by professors of the Sorbonne, are apart both in their location and in their mode of treatment from the other courses at the Faculté des Sciences. The professor of zoology at the P. C. N., as the premedical school is called (physical, chemical, natural sciences), is Rémy Perrier, brother of the famed comparative anatomist, Edmond Perrier; he has continued, in a way, the latter's work. He is ably seconded by Georges Bohn, who has done much work on comparative psychology and on the chemical aspects of biology. Zoology for non-premedical students is taught by Professors Charles Pérez and Hérouard, both of them morphologists, in the laboratory lately held by Yves Delage. Comparative anatomy and histology are in the hands of Professor Paul Wintrebert, whose work has mostly been in experimental zoology. General biology and embryology are taught both at the Laboratoire d'Evolution des Êtres Organisés, by Professor Maurice Caullery and M. François Picart, and at the Laboratoire de Biologie Expérimentale, by Professor Etienne Rabaud. At the École Normale Supérieure the laboratory of zoology is directed by Professor Robert Lévy.

Besides these teaching laboratories, there are others where only research is ordinarily carried out. Such are the biological laboratories of the Collège de France and of the Muséum d'Histoire Naturelle. In the former institution the chair of comparative embryology is held by Professor Henneguy, ably seconded by M. E. Fauré-Frémiet; in this laboratory much experimental work is being carried out. The chair of histology is in the hands of Professor Nageotte, while there has been recently created a chair of physiological histology for Professor Jolly. At the Muséum d'Histoire Naturelle there are several laboratories of zoology, which are mainly devoted to taxonomy and morphology. Chief among them are the laboratories of Professor Bouvier, in entomology, Professor Roule, in herpetology and ichthyology, Professor Gravier, in Crustacea and worms, Professor Joubin, in Coelenterates, Professor Anthony, in comparative anatomy of vertebrates. Similar laboratories, dealing with marine life, exist at the Institut Océanographique.

Of interest also to zoologists are the laboratories of histology of Professor A. Prenant, and of parasitology of Professor Brumpt—at the Faculté de Médecine—and of parasitology of Professor F. Mesnil, at the Institut Pasteur.

General physiology at the Sorbonne is taught by Professor Lapicque, the discoverer of chronaxy. His laboratory deals very largely with the physical aspects of physiology. On the contrary, in Professor A. Mayer's laboratory at the Collège de France, and in Professor Portier's laboratory of comparative physiology at the Sorbonne, it is the chemical aspects which are largely stressed. At the Collège de France also is the laboratory of Professor Gley, where the work deals with hormones and with the nervous system. Professor Richet's recent chair at the medical school is now occupied by Dean Roger, while there is also located here the laboratory of Professor Gautrelet, attached to the École des Hautes Études.

Biochemistry is taught at the Sorbonne by Professor Gabriel Bertrand, whose work deals mostly with enzymes and the physiological action of metals, and by M. Javillier, of the Institut Agronomique. At the medical school biochemistry is in the hands of Professor Desgrez.

Botany is extensively studied at the Sorbonne. Plant morphology is taken up by Professor Dangeard, cytology by Professor Guilliermond, while plant physiology is taught by Professor Molliard. The biological aspects of botany, such as variation, heredity, etc., are studied under the direction of Professor Blaringhem.

Attached to the University of Paris are three marine biological stations and several stations for botanical and limnological investigations. Of the marine stations, the one at Wimereux, Pas-de-Calais, is small, while the ones at Roscoff, Finistére, and Banyuls, Pyrénées-Orientales, are modern and well equipped. The direction of these stations is in the hands, respectively, of Professors Caullery, Pérez and Dubosecq.

Of interest also are the independent marine stations of Monaco and of Salammbô, Tunis.

The main provincial cities where biological research is being actively carried out are Strasbourg, Montpellier, Nancy, Lyon. In Strasburg are Professors Bouin and Ancel, who have done remarkable work on the biology of sex; Nicloux and Blum, who have applied to biochemistry the methods of micro-chemistry; the physico-biologist, Vlès, the physiologist Terroine, the protozoologist Chatton, besides many younger able men. At Montpellier are the experimental zoologist Bataillon, the comparative anatomist Vialleton, the histologists Hollande and Turchini, and the physiologists Hédon and Derrien. At Nancy is the school formed by Professor Cuénot, leader of French geneticists, while at Lyon an outstanding figure is Professor Policart, physiological histologist.

In all the laboratories which have been enumerated, as well as in all other French research laboratories, foreign investigators are made welcome. American biologists coming to work in France should not, however, choose any laboratory in which to do their investigation before meeting the various directors personally. The various laboratories differ so much from each other, in both spirit and equipment, that it is far preferable to decide "sur place" which suits best one's particular needs.

The spirit of individualism and personal liberty, preeminent in France, is amply reflected in the life of its laboratories. Americans, accustomed to a system which has a tendency to over-organization in science, can greatly benefit from association with a method which is totally different from their own.

RAOUL M. MAY

AMERICAN FIELD SERVICE,
PARIS, FRANCE

SCIENTIFIC EVENTS

LECTURES AT THE ROYAL INSTITUTION

THE following lecture arrangements at the Royal Institution before Easter next year have been announced: The Christmas course of six lectures for juveniles were delivered by Professor A. V. Hill, on "Nerves and Muscles: how we feel and move," commencing on December 28. On Tuesdays, at 5.15 P. M., beginning on January 18, there will be two lectures by Professor R. Whytlaw-Gray on smokes as aerial disperse systems; six by Professor Julian Huxley on problems of animal growth and development; two by Dr. G. Shearer on X-rays and the chemical molecule, and two by Professor J. W. Cobb on some properties of coke. Thursday afternoon lectures, at the same hour, include three lectures by Sir William Bragg on acoustical problems treated by Lord Rayleigh; three by Professor John Garstang on the progress of Hittite studies; two by Mr. J. Guild on color measurement and standardization, and two by Mr. Harold J. E. Peake on the beginnings and early spread of agriculture. Saturday afternoon lectures, at 3 P. M., include four by Sir Ernest Rutherford on the α-rays and their application to atomic structure. The Friday evening meetings will begin on January 21, when Sir William Bragg will deliver a discourse on Tyndall's experiments on magne-crystallic action. Succeeding discourses will probably be given by Professor E. P. Cathcart, Mr. T. L. Eckersley, Dr. Ernest Law, Sir Josiah Stamp, Professor D'Arcy Thompson, Sir Herbert Jackson, Dr. George Macdonald, Mr. E. Hatschek, Professor C. T. R. Wilson, Sir Ernest Rutherford and others.

PUBLIC LECTURES AT THE HARVARD MEDICAL SCHOOL

THE faculty of medicine of Harvard University is offering a course of free public lectures on medical subjects, at the Medical School, Longwood Avenue, Boston, on Sunday afternoons at four o'clock, beginning on January 9 and ending March 27.

January 9.—*Healthy children.* Dr. Richard M. Smith, assistant professor of child hygiene.

January 16.—*The public health aspects of venereal diseases.* (To women only.) Dr. Myrtelle M. Canavan, curator of the Warren anatomical museum.

January 23.—*Alcoholism, syphilis, and some other conditions as causes of mental disease.* Dr. Harry C. Solomon, instructor in neuropathology and associate in psychiatry.

January 30.—*The dangers of overweight.* Dr. Lawrence T. Fairhall, instructor in physiology.

February 6.—*The internal secretions.* Dr. Joseph C. Aub, assistant professor of medicine.

February 13.—*Some causes of bladder trouble.* (To men only.) Dr. J. Dellinger Barney, assistant professor of genito-urinary surgery.

February 20.—*The problem child.* Dr. Douglas A. Thom, instructor in psychiatry.

February 27.—*How the nerves, eyes, nose and throat may be affected by the teeth.* Dr. George H. Wright, assistant professor of dentistry.

March 6.—*The meaning of blood pressure.* Dr. William H. Robey, assistant professor of medicine.

March 13.—*Fresh air, sunlight, and vitamines.* Dr. Edwin T. Wyman, instructor in pediatrics.

March 20.—*Something about dreams.* Dr. Percy G. Stiles, assistant professor of physiology.

March 27.—*Cancer and new growths.* Dr. Shields Warren, instructor in pathology.

GIFT OF THE ROEBLING MINERAL COLLECTION TO THE SMITHSONIAN INSTITUTION

WHAT is said to be the finest private collection of minerals in the world, belonging to the late Colonel

Washington A. Roebling, builder of the Brooklyn Bridge, has been given by his son, Mr. John A. Roebling, to the Smithsonian Institution. Accompanying the gift is an endowment of $150,000 to insure the maintenance of the collection.

This gift makes the Smithsonian Institution the possessor of the two greatest private mineral cabinets in this country, received within two months of each other. The first, containing 9,000 specimens, which is only surpassed by the Roebling collection of 16,000 specimens, came from Mr. Frederick A. Canfield, of New Jersey. It is also endowed to the amount of $50,000. These two gifts added to the 50,000 mineral specimens already owned by the Smithsonian put the institution ahead of any other in this country in mineralogical material, and class it with the British and Vienna Museums in the front of the world.

It has been claimed for the Roebling collection that it contains a greater number of species than any other, public or private, in the world. The number of well-defined species of minerals is about 1,500. Colonel Roebling lacked less than 15 of these. Included are an almost complete series of the varieties and of all dubious mineral species. In his attempt to get specimens of every known mineral, he kept an up-to-date list of desiderata, circulating copies of this among mineralogists and dealers in all corners of the globe.

The collection contains a number of rarities such as a 64 carat black diamond from South Africa. It is a perfect crystal and is believed to be one of the largest black diamond crystals known. A group of nine Arkansas diamonds contains one of 18 carats, which was, up till two years ago, the largest known from Arkansas. A black opal from Humboldt County, Nevada, weighs 18-6/10 ounces, being the largest precious opal known.

Among the cut stones there is a 319 carat peridot from the Island of Saint John in the Red Sea. It is supposed to have adorned the image of a saint in an Austrian church for some three centuries. A wine colored topaz from Brazil weighs 93 carats. An exceptional alexandrite of 32 carats from Ceylon shows green in sunlight and red in artificial light.

The finest group of precious tourmalines ever taken from Mesa Grande, California, are included in the Roebling collection. Maine contributed its finest purple apatite. A rare four carat cut blue euclase from Brazil is exceptional in color and size.

The collection contains many type specimens, which greatly enhance the scientific value of the cabinet, while the number of dubious minerals included will provide the Smithsonian mineralogists an opportunity to reinvestigate them and determine what they actually are.

REVISION OF THE U. S. PHARMACOPOEIA

SINCE the appearance of the tenth revision of the "Pharmacopoeia of the United States" the committee entrusted with the task of preparing this national standard has turned its attention to the problems that will arise in the preparation of the eleventh revision in 1930. Many revision problems involve extended research and the revision committee is hopeful that individual workers will take up these problems as a part of their regular research work.

A list of chemical problems has therefore been submitted to American chemists with the hope of interesting them in this field of research. Perhaps some of the problems are already being studied by certain chemists; perhaps others may interest individual chemists now looking around for a useful subject for research. In either event, it is desired that the person engaged in the specific research notify Chairman E. F. Cook, U. S. P. Revision Committee, 636 South Franklin Square, Philadelphia, Pa., or the chairman of the research group on chemistry, Dr. H. V. Arny, stating the topic of research taken up and when the research is finished either send in information as to where the article will be found, or better still, send in a reprint of the article. Copies of the list may be obtained by addressing the office of the general chairman.

The list of problems upon which information is desired has for convenience been classified under five divisions, each division having the corresponding members of the executive committee of revision, one member serving as chairman of the group. The divisions are as follows: (1) Committee on therapeutics and pharmacologic research, H. C. Wood, Jr., *chairman*, with C. W. Edmunds, George W. McCoy and Torold Sollmann; (2) committee on pharmacognostic research, Edwin L. Newcomb, *chairman*, with W. O. Richtmann; (3) committee on chemical research, H. V. Arny, *chairman*, with Frank R. Eldred, Charles H. LaWall, W. O. Richtmann and George D. Rosengarten; (4) committee on pharmaceutical formulas and processes, Wilbur L. Scoville, *chairman*, with George M. Beringer and Jacob Diner; (5) committee on miscellaneous research topics, A. G. DuMez, *chairman*, with Theodore J. Bradley.

NEW LABORATORY OF ENGINEERING FOR LEHIGH UNIVERSITY

A GIFT of a million dollars for the erection of an electrical and mechanical engineering laboratory at Lehigh University by James Ward Packard, a graduate of the class of 1884 and originator of the Packard automobile, was announced at a meeting of the board of trustees of Lehigh University on January 14. The

gift is unconditional. The new building will be known as the James Ward Packard laboratory. This is the largest gift ever made to Lehigh University by a single individual since its establishment in 1865 by Asa Packer.

Preliminary plans for the James Ward Packard laboratory have been prepared by Visscher and Burley, architects, of New York. It will have an overall width of 225 feet and a depth of 184 feet, designed in the collegiate Gothic style with exterior walls of native stone trimmed with cut limestone. The main laboratories will be provided with electrical and mechanical equipment of the most modern and efficient type for experiment and instruction purposes. From the heaviest boilers, prime movers and generators to the most delicate known devices for precise measurement, every type of equipment needed for the study of mechanical and electrical engineering will be the finest obtainable. Special laboratories for research in radio, high voltage work, fuels, refrigeration and other special branches of technology are planned. Drafting rooms, an engineering library, an auditorium seating 500 and equipped with stereopticon and motion picture projectors and an engineering museum are also included in the plans.

THE TENNESSEE ANTI-EVOLUTION LAW

THE Supreme Court of Tennessee on January 15 handed down a decision upholding the constitutionality of the law prohibiting the teaching in state supported schools that man is descended from a lower order of animals. Before reading the opinions, Chief Justice Green made a statement in summary of the results of the court's deliberations, saying, according to an Associated Press dispatch:

> The majority of the court holds the act to be constitutional—Judge Cook, Judge Chambliss and myself. Judge McKinney believes the act invalid and will state his reasons.
>
> Judge Cook and I think the act prohibits broadly the teaching in the schools of the state that man descended from a lower order of animals. Judge Chambliss thinks the act only prohibits the teaching of the materialistic theory of evolution, which denies the hand of God in the creation of man. He will state his reasons.
>
> All of us agree that the judgment herein must be reversed on account of the error of the trial judge in attempting himself to fix a fine of $100 upon Scopes. Under the constitution of Tennessee a fine in excess of $50 can only be assessed by a jury. The jury in this case returned a verdict of guilty, but did not assess the fine and the judge undertook to do this himself.
>
> Since the minimum punishment authorized by the statute is a fine of $100 and no tribunal except a jury can levy such a fine in this state, the error pointed out can only be corrected by awarding a retrial.
>
> All of us agree that nothing is to be gained by prolonging the life of this bizarre case. On the contrary, we think that the peace and dignity of the state, which all criminal prosecutions are brought to redress, will be subserved by the entry of a nolle prosequi herein. Such a course is suggested to the Attorney General.

Regarding the effect of the ruling the majority opinion said:

> As the law thus stands, while the theory of evolution of man may not be taught in the schools of the state, nothing contrary to that theory is required to be taught. It could scarcely be said that the statutory scriptural reading would amount to teaching of a contrary theory.
>
> Our school authorities, are, therefore, quite free to determine how they shall act in this state of the law, and this course of study may be entirely omitted from the curriculum of our schools.

The opinion declares it seems plain that the Legislature only intended "to forbid teaching that man descended from a lower order of animals. The denunciation of any theory denying the Bible story of creation is restricted by the caption and by the final clause."

Justis Chambliss asserted in his separate opinion concurring with the majority decision that the teaching of materialistic evolution only was forbidden by the act:

> It follows that to forbid the teaching of the biblical account of divine creation does not expressly or by fair implication involve acceptance or approval of instantaneous creation held to by some literalists.
>
> One is not prohibited by teaching, either "days" as used in the book of Genesis, means days of twenty-four hours, the literalist view, or days of "a thousand years" or more, as held by liberalists, so long as the teaching does not exclude God as the author of human life.

Justice McKinney's dissenting opinion declared his belief that the statute is invalid "for uncertainty of meaning." He quoted in support of his belief the opinion of the Supreme Court of the United States in the case of Connally versus General Construction Company as follows:

> That the term of a penal statute creating a new offense must be sufficiently explicit to inform those who are subject to it what conduct on their part will render them liable to its penalties is a well recognized requirement, consonant alike with ordinary notions of fair play and the settled rules of law; and a statute which either forbids or requires the doing of an act in terms so vague that men of common intelligence must necessarily guess at its meaning and differ as to its application violates the first essential of due process of law.

SCIENTIFIC NOTES AND NEWS

DR. H. R. KRUYT, of the University of Utrecht, will be guest of honor at the fifth National Colloid Symposium, which is to be held in Ann Arbor from June 22 to 24. Dr. Kruyt has accepted a lectureship in colloid chemistry at the University of Michigan for the coming summer session.

DR. PETER DEBYE, formerly professor at the University of Utrecht and of Göttingen and now head of the physics department at the technical high school in Zürich, Switzerland, has been appointed acting professor of mathematical physics at the University of Wisconsin for the second semester.

PROFESSOR GILBERT N. LEWIS, head of the department of chemistry at the University of California, will spend the next summer quarter at the University of Chicago as the first holder of the Ernest A. Hammill visiting professorship. Dr. Lewis will present a lecture course on "Valence and the Structure of the Atom" and will also conduct a seminar in the field of thermodynamics.

DR. S. A. WAKSMAN, associate professor in soil microbiology at Rutgers University, was elected corresponding member of the Russian Microbiological Society, Leningrad, U. S. S. R., on December 16.

THE John Scott Medal, founded in 1816 by John Scott, of Edinburgh, and awarded from time to time by the board of city trusts of Philadelphia for outstanding inventions, has been awarded to Gustaf Waldemar Elmen for his invention of permalloy.

GEORGE EASTMAN, founder and president of the Eastman Kodak Company, has been awarded the progress medal of the Royal Photographic Society of Great Britain. The award was made "in recognition of Mr. Eastman's inventions, researches and publications, resulting in an important advance in the development of photography."

THE New York Rotary Club presented a wrist watch to Captain Roald Amundsen, discoverer of the South Pole and commander of the dirigible *Norge* in its recent North Pole flight, at a luncheon on January 13 at the Waldorf-Astoria, New York. Captain Amundsen told of his polar experiences.

A TESTIMONIAL banquet, given by three hundred members of the Boston Tufts Alumni Club, was given at the new University Club to Dean Gardner C. Anthony, retiring head of the Tufts Engineering School. The banquet was presided over by Professor Edwin A. Shaw, retiring president of the Alumni Club. The speakers included ex-Mayor Richard B. Coolidge, of Medford, President Cousens and Rev. John J. Mark, of Fall River.

DR. C. W. JOHNSON, dean of the school of pharmacy in the University of Washington, has been elected president of the American Pharmaceutical Association.

THE following officers and council for 1927 were elected at the Birmingham-Atlanta meeting of the American Institute of Chemical Engineers: *President,* E. R. Weidlein; *third vice-president,* R. T. Haslam; *secretary,* H. C. Parmelee; *treasurer,* M. H. Ittner; *directors,* N. K. Chaney, H. A. Curtis, D. D. Jackson.

THE Rockefeller Institute for Medical Research, New York, announces the appointment to its scientific staff in the division of biophysics of Dr. Ralph W. G. Wyckoff as associate member and Dr. Sterling B. Hendricks as assistant, formerly of the geophysical laboratory of the Carnegie Institution of Washington.

WALTER C. HENDERSON has been promoted by the secretary of agriculture to be associate chief of the U. S. Biological Survey, a new position in that bureau, created on January 1.

W. R. SINGLETON, graduate student at the Bussey Institution, has been appointed as assistant geneticist at the Connecticut Agricultural Experiment Station.

B. C. RENICK has resigned from the U. S. Geological Survey and has gone into commercial geological work.

DR. A. S. PEARCE, professor of zoology in Duke University, recently traveled over seven hundred miles into the interior of Nigeria. He is now at the British Museum working on the rodents collected and expects to return to Duke University about January 25.

DR. HAROLD S. BURR recently returned from a six months' absence abroad, spent in study of neurology in Amsterdam and London while holding a Sterling Fellowship. He has been promoted from the rank of assistant professor to that of associate professor of anatomy at Yale University.

DR. E. S. SCHULTZ, pathologist of the U. S. Department of Agriculture, is continuing the work on potato mosaic and other virus diseases at the Boyce Thompson Institute, at Yonkers, N. Y.

DR. EDWIN B. FROST, director of the Yerkes Observatory and professor of astrophysics at the University of Chicago, will give a public lecture at the University of Minnesota on February 6 under the auspices of the zoological museum. The title of Dr. Frost's lecture is "Seeing Stars."

DR. W. T. BOVIE, assistant professor of bio-physics at the Harvard Medical School, addressed a regular meeting of the Chicago section of the American Chem-

ical Society on January 14 on "The Biological Effects of Light."

PROFESSOR F. R. MILLER, of Western University, London, Ontario, lectured on the "Function of the Cerebellum" on January 4 before the University of Buffalo Medical School and members of the Buffalo Academy of Medicine.

DR. WILSON G. SMILLIE, of the International Health Board, addressed the Rockefeller Institute for Medical Research on January 7 on "The Influence of Natural Factors in the Distribution of Disease."

DR. GEORGE W. MOREY, of the Geophysical Laboratory, Washington, will address the Franklin Institute on January 27 on the "Chemical Basis of Glass Technology."

PROFESSOR HENRI FREDERICQ, head of the department of physiology at the University of Liège, Belgium, spoke on "Humoral Transmission of Nervous Action" at a meeting of the Harvard Medical Society on January 11. On the following evening he addressed a physiological conference at the Harvard Medical School on "Chronaxia: the Measurement of Excitability in Living Tissues."

THE Hunterian lecture was delivered before the Hunterian Society of London on January 17 by Dr. J. M. T. Finney, professor of surgery at the Johns Hopkins University, who chose as his subject "The Influence of John Hunter on American Surgery."

THE Kamerlingh Onnes Memorial lecture of the British Chemical Society will be delivered by Professor Ernst Cohen, of Utrecht, at the Institution of Mechanical Engineers, London, on February 10.

PROFESSOR E. P. LEWIS, head of the department of physics in the University of California, died on November 17, 1926, aged sixty-three years.

SIR JOHN SCOTT KELTIE, the well-known British geographer, died on January 12, aged eighty-six years.

DR. T. S. P. STRANGEWAYS, Huddersfield lecturer in special pathology in the University of Cambridge and director of the Cambridge Research Hospital, died on December 23.

AT memorial exercises held at the Medical College of Virginia, Richmond, on January 7, for Dr. John W. Brodnax, anatomist and artist, who died last October, papers were read by Dr. W. Lowndes Peple, Dr. Robert C. Bryan, Dr. H. L. Osterud, Dean W. F. Rudd and Mr. Rufus Alley. Dr. Brodnax was a member of the department of anatomy of the Medical College of Virginia for thirty-three years.

AN effort is being made to obtain twenty thousand dollars to endow a fellowship at the Johns Hopkins University, to be known as the Brooks Research Fund and to be administered by the philosophical faculties in zoology and botany engaged in research, for the benefit of exceptional young men who may be laying the foundations for research careers in those subjects. About nine thousand dollars has been subscribed in sums from two to one thousand dollars. Checks may be sent to any of the following committee: E. A. Andrews, R. P. Bigelow, H. L. Clark, E. G. Conklin, R. E. Coker, W. C. Coker, R. P. Cowles, W. C. Curtis, H. H. Donaldson, G. A. Drew, C. Grave, L. E. Griffin, R. G. Harrison, F. H. Herrick, W. H. Howell, D. S. Johnson, J. L. Kellogg, H. McE. Knower, I. F. Lewis, J. P. McMurrich, M. M. Metcalf, T. H. Morgan, H. L. Osborn, C. P. Sigerfoos, D. H. Tennent, S. Watasé, C. B. Wilson, E. B. Wilson and H. V. Wilson.

THE United States Civil Service Commission announces an open competitive examination for associate agricultural chemist at a salary of $3,000 a year, applications for which must be received not later than February 21.

THE twenty-sixth western meeting of the American Mathematical Society was held at the University of Chicago on December 31. The attendance was about seventy-five, among whom were fifty-four members of the society. Thirty papers were read at this meeting. The next western meeting of the society will be held at the University of Chicago on April 15 and 16. At this meeting Professor E. W. Chittenden, of the University of Iowa, will deliver a lecture on "Some Phases of General Topology."

THE annual meeting of the American Ceramic Society will take place in the Hotel Book-Cadillac, Detroit, Michigan, from February 14 to 19. The preliminary program has been issued and contains titles of over one hundred papers.

A SYMPOSIUM on gasoline, announced as the largest open meeting devoted solely to the subject of liquid fuels that has ever been held in this country, was held at the Massachusetts Institute of Technology on January 15, under the auspices of the Northeastern Section of the American Chemical Society.

A BILL to prohibit the teaching of every theory of evolution that denies the divine creation of man was introduced in the Alabama House of Representatives on January 12 by the Rev. C. O. Thompson, of Etowah.

A RESOLUTION (House Joint Resolution No. 328) authorizing the appropriation of $5,000 for the expenses of the United States delegates to the Congress of Military Medicine and Pharmacy, to be held at

Warsaw, Poland, has been introduced in the House by Representative Porter, of Pittsburgh.

A HEARING on methods of further restricting the killing of migratory wild fowl was held at Washington on January 20. All interested persons were given opportunity to be heard on the question of better protection for migratory wild fowl through reduction in bag limits, establishment of rest days, shortening of seasons, or otherwise.

THE Crawford W. Long prize for research work will be awarded at the next annual meeting of the Medical Association of Georgia for the best original work accomplished by a member of the association during the year. The donor, who desires to remain anonymous, will offer the prize annually as long as he lives.

THE extensive collection of insects included in Baltic amber collected by the late Professor R. Klebs, of Königsberg, has been purchased for the geological institute of the University of Königsberg, which already possesses a large cabinet of these objects. Properly qualified research workers will now, as in the past, be accorded facilities for the study of these collections.

THE program for the second series of free public lectures at the Victoria Memorial Museum, illustrated by lantern slides and supplemented by motion pictures, has been issued. These lectures are given weekly on Saturday mornings for school children and repeated on the following Wednesday evening for adults. The first lecture was given on January 8 by C. M. Sternberg, of the Canadian Geological Survey, on "The Age of Reptiles," and the series is to be continued by the following: B. R. MacKay, of the Canadian Geological Survey, "A Piece of Coal"; Clyde L. Patch, of the Victoria Memorial Museum, "What are Snakes good for?"; F. T. Wahlen, of the Canadian Seed Branch, "The Story of Good Seed"; G. S. Hume, of the Canadian Geological Survey, "Petroleum and Natural Gas"; L. S. McLaine, of the Canadian Entomological Service, "Small Friends and Foes"; M. E. Wilson, of the Canadian Geological Survey, "Five Weeks in Sunny Spain"; J. A. Rodd, of the Dominion Fisheries Service, "Fish Culture"; G. E. McIntosh, fruit commissioner of Canada, "The Fruit Industry of Canada"; J. Dewey Soper, of the Victoria National Museum, "A Naturalist in Baffin Island." The lecture committee consists of Harlan I. Smith, M. E. Wilson and Clyde L. Patch.

DURING the year 1926 the People's Commissariat for Education of the Union of Socialist Soviet Republics has sent abroad a number of scientific men to participate in fourteen congresses on various scientific subjects, including medicine, agriculture, geology, botany, philosophy and astronomy. It is planned to increase the number to seventy-three this year.

AN expedition to the Sudan has been sent out by the American Museum of Natural History through the generosity of Irving K. Taylor, a well-known explorer. This is to be known as the Taylor-Sudan Expedition and is to be under the direction of Mr. Taylor and of Harold E. Anthony, curator of mammals in the American Museum of Natural History. Both men have left for Italy where they will meet and proceed to Alexandria. Necessary material will be assembled at Khartoum, the point which has been selected as the base of operations. The primary purpose of the Sudan expedition is to secure large study collections of the fauna of the regions to be visited, together with both moving pictures and other photographs of the specimens. If it is found possible to secure good exhibition material this will be used for the proposed hall of mammals of the world in the museum. It is expected that the expedition will be gone about six months.

THE seventh summer term of the American School of Prehistoric Research will open in London on June 27 under the direction of Dr. George Grant MacCurdy, of Yale University, and close in Zurich on September 20. The itinerary will include southern England, Brittany, northern Spain, the Pyrenees, Dordogne and Switzerland. About one third of the time will be devoted to actual excavating; the remainder to study of prehistoric collections and sites, and conferences with the director and various foreign specialists.

WILLIAM J. MORDEN, of Chicago, and James L. Clark, head of the department of preparation of the American Museum of Natural History, have arrived in Pekin after a prolonged journey through Chinese Turkestan. They had intended to return to New York November 1, and now expect to reach there late in February. Mr. Morden and Mr. Clark left Bombay early last March, traveling over little known trails from Srinagar, in India, through Chinese Turkestan and along the borders of the Gobi Desert, across the Altai Mountains to Ulyasutai, thence to Biisk, the railroad head on a branch of the Transsiberian Railroad.

GIFTS of $1,565,000, some made public during the year, were announced on December 26 at the annual dinner of the board of managers of the New York Zoological Society given by Edwin Thorne, at the University Club. Madison Grant, president of the society, reviewed the work of the year and told of additions to the endowment, of which $1,000,000 was

made by the late Anna M. Harkness; $500,000 by John D. Rockefeller, Jr., a duplicate of his gift of several years ago; $25,000 from Coleman du Pont; $25,000 from Mortimer L. Schiff and $15,000 from Edwin Gould.

ACCORDING to *Museum News*, a bill authorizing an appropriation of $820,000 for a larger botanical garden in Washington has been passed by the U. S. House of Representatives. Two additional city blocks will be purchased with this amount and the present buildings removed. This new property which adjoins the present botanical garden will nearly double the area. The removal of the Bartholdi fountain from its present position, provided for in the new measure, will make it possible to bring the garden into closer harmony with the Capitol grounds.

AN addition of 80,000 acres to the Monongahela National Forest on the head waters of the Potomac River has been authorized by the National Forestry Commission. The land lies in the Seneca Park section of the Alleghanies, near Spruce Mountain, the highest peak in West Virginia, and will bring the area of that park to 189,520 acres. Other authorizations by the commission included the purchase of 35,334 acres as additions to eastern national forests, and a recommendation, sent to President Coolidge, that 430,437 acres be acquired for extension of western national forest reserves. Purchases in Pennsylvania comprised 15,131 acres in Elk, Warren and Forest Counties. In Oxford County, Maine, 469 acres were authorized for purchase. The western extensions asked for included 224,257 acres for the Missouri and Helena National Forests, Montana; 137,480 acres for the Idaho, Sawtooth and Challis National Forests, Idaho; 67,000 acres for the Wyoming National Forests, and 1,720 for Colonial Forests, Washington.

A COMPLETELY equipped X-ray laboratory, marking a new departure in museum practice, has been installed at the Field Museum of Natural History, Chicago. Stanley Field, president of the museum, financed the equipment of the laboratory, which has been developed as a division of roentgenology. Primarily the laboratory is to aid in the examination, differentiation and classification of natural history specimens. The X-ray is expected to prove of value in the study of the bones of mummies and other objects.

WESTERN RESERVE UNIVERSITY has announced that J. G. Sholes, president of the Ohio Chemical and Manufacturing Company, has made an annual grant of two thousand dollars for the establishment of fellowships for the study of gases to be carried on under the direction of Dr. H. S. Booth, of the department of chemistry of the university, the work to be done in the Morley chemistry laboratory. The fellowships will be known as "The Ohio Chemical Fellowships" and will be devoted to pure science researches on gases with particular emphasis on the gases of value as anesthetics. The university will immediately consider applications for the fellowships, so that their research may start with the beginning of the second semester.

ACCORDING to *Nature*, Mr. Heron-Allen has presented the Heron-Allen and Earland collection of Foraminifera to the British Museum of Natural History under conditions which will enable him and his collaborator to keep it up-to-date, with additions and rearrangement. The collection, which numbers between seventeen and eighteen thousand slides, includes the Millett, Siddall, Sidebottom and other notable collections, and is said to be the largest and most complete in the world.

A GOLD medal has been awarded to the New York State College of Forestry, Syracuse University, for its educational service connected with the conservation of the forest, by the Sesqui-Centennial Exposition. The diploma for this award is being prepared and will probably be ready for presentation during the early part of 1927. The award was in connection with a series of exhibits prepared by the college, showing the progress made in forestry educational methods, in presenting forestry to the public, and the manner in which students have been brought into direct contact with the subject by taking them into the field where actual operations of forest management are conducted.

THE Eastern Siberian section of the Russian Geographical Society announces the celebration of its seventy-fifth anniversary at the end of this month. The occasion is to be marked by various social functions and an exhibition illustrating the results of the society's work in Siberia. Various publications are also announced, including the fifteenth volume of the *Isvestia*, with a series of historical articles and a volume of general geographical and statistical articles on Eastern Siberia.

UNIVERSITY AND EDUCATIONAL NOTES

THE University of Pennsylvania has received a contribution of $250,000 from the Carnegie Corporation for the endowment of medical research in the university's school of medicine and a gift of $25,000 from Charles H. Ludington for research work in the Henry Phipps Institute during the current year.

COLONEL HENRY W. SACKETT, of New York City, has given to Cornell University $200,000 to provide for the permanent conservation of the landscape beauty of the university's campus.

CONTRACTS have been let for the construction of the Service Memorial Institute which will be a unit in the group of buildings devoted to medical instruction at the University of Wisconsin. Some $600,000 of the surplus from the Wisconsin's Soldiers' Rehabilitation fund are available, under legislative enactment, for building the structure. It will provide quarters for the research and clinical work of various departments of the medical school.

THE Chicago Lying-in Hospital has announced plans for its affiliation with the University of Chicago. A new $1,000,000 building will be erected on the university campus.

DEAN CHARLES H. SNOW has announced the establishment of a course of study leading to the graduate degree of aeronautical engineer in the Daniel Guggenheim School of Aeronautics of New York University. The school was established in 1925.

AT Princeton University, Dr. William T. Thom, Jr., chief of the fuel section of the United States Geological Survey, has been appointed associate professor of geology, and Dr. Robert N. Pease, associate professor of chemistry at the University of Virginia, research associate in chemistry.

RECENT graduates of the University of Wisconsin with pharmacy as a major have received appointments as follows: L. E. Harris has returned to the University of Oklahoma, where he previously held the position of assistant professor in pharmacy; H. G. Hewitt has accepted a position in the College of Pharmacy, University of Buffalo; G. L. Jenkins has been reappointed as instructor in pharmacy at the University of Wisconsin; K. H. Rang has accepted a position in the University of Saskatchewan, department of pharmacy; Petrocinio Valenzuela has returned to the University of the Philippines, in the College of Pharmacy, in which he previously held a professorship.

H. MUNRO FOX, fellow of Gonville and Caius College, Cambridge, has been appointed to the Mason chair of zoology at the University of Birmingham, to succeed the late Professor F. W. Gamble.

DISCUSSION AND CORRESPONDENCE

KINETIC ACTIVITY, ORIENTED ADSORPTION AND MOLECULAR DEFORMATION AS FACTORS IN CATALYSIS

IF a swinging magnet passes near a fixed one, so that there is a close approach of like poles, the swinging magnet is deflected from its course or is even made to recoil. This simple device was used by Sir Ernest Rutherford to illustrate the influence of atomic nuclei on alpha particles shot out by radium.

If, in this experiment, the poles are of opposite polarity, they will attract each other; but the velocity of the moving magnet will determine whether or not the two will cohere. The most favorable condition for cohesion is naturally a direct head-on meeting at a relatively low velocity, whereas an off-center approach at relatively high velocity is unfavorable. Analogous conditions govern the fate of comets which approach the sun.

Atoms and molecules are no longer regarded as tiny little hard balls, for we now know them to be highly organized structures, most of which have, or may be made to have, some kind of polarity, which may result in their mutual cohesion. Chemical combination is a special case of such cohesion. From the fact that most atoms and molecules are able to build up, under proper conditions, into chains or three dimensional groups, it seems evident that they have a plurality of areas of charge or polarity. The tendency of these aggregations to crystallize, that is, to assume regular but various space lattices, having cleavage planes of unequal strength, further indicates that the fields of the particles (atoms or atomic groups) are of unequal strengths at different places, and are, in the course of group or crystal formation, in some way adjusted or fitted to each other. Possibly these particle fields are the net result of the motion of the constituent electronic units.

The more highly complicated the particles (atoms, molecules or molecular groups), the less the probability that they will present to each other their various polar areas in such fashion that true crystal-lattice or crystallographic union may take place, with the elimination of solvent or other adsorbed film, if such there be. To effect such union speedily, the meeting, besides being properly oriented, must be at an efficient velocity. However, since most particles have a plurality of areas of electric or magnetic fields, some kind of attachment less rigid or lasting than true chemical combination may occur. This seems to account for the tendency of more complicated molecules to form haphazard or random groups, or aggregations of such groups, from which, however, they *tend* to move toward their position of minimum potential—one big crystal. If for any reason (*e.g.*, adsorption of ions) groups acquire like charges of sufficient strength, the resulting repulsive forces will militate against union, and we have the time-lag characteristic of the colloidal state.

Transferring these ideas of optimum kinetic velocity and of oriented meeting to catalytic phenomena, the function of a catalyst may be pictured in three stages:

First, the catalyst binds or adsorbs a reacting constituent and holds it relatively immobile.

Second, the bound particles are held in oriented fashion (oriented adsorption), so that they present to the other reacting particles, fields most favorable to adherence to or combination with them.

Third, the electromagnetic or electrostatic fields of the reacting particles thus joined react on each other in such a way that the bond between the inner particle and the catalyst is broken, while that between the two reacting particles persists (synthesis).

This scheme demands a fitting together of the fields of the catalyst and those of one of the reactants, which may well serve as the basis of the "lock and key" comparison of Fischer, and the specificity of many biological, enzyme and catalytic reactions. It is also consonant with Professor Hugh S. Taylor's demonstration of selective points of activity, for it is not to be expected that all areas of the catalyst surface will be equally effective in holding particles arriving there with the criteria of successful fixation at an area of properly distributed charges—*i.e.,* proper presentation and proper velocity.

When a particle is fixed or adsorbed at an interface or effective catalyst area, the fields of the particle adjacent to the surface are largely balanced by the opposing surface fields. This neutralization should lead to a redistribution of the remaining charges of the particle, with the result that the exterior portion of the particle exposed to the solution then has a different electromagnetic or electrostatic configuration from what it had before fixation. It may now make attachments previously not possible.

If this new configuration is such that it permits the attachment of another kind of particle, there will be another readjustment of fields, with the following two possibilities: (1) If the bond between the two particles persists while that between the catalyzer surface and the now duplex particle breaks, we will have set free into the solution a new duplex particle which will undergo a readjustment of fields as soon as it breaks loose. The active catalyst area will then be free to begin the operation over again. (2) If the duplex particle sticks to the active area, activity there ceases. The same result follows if a non-reactive particle sticks to the active area (poisoning of catalyst), and it is conceivable that the fields of an active area may be so distorted as a result of conditions during use, that their activity diminishes and the catalyst becomes "worn out."

If the readjustment of fields following the fixation of a particle *at* an interface, or following the separation of composite particle *from* an interface, is such that the particle in question splits up, *decomposition* is catalyzed. The nature of the split determines the kind of products formed thereby. If a composite particle persists on liberation, we have a *synthesis.*

Consider now the effect of an increase in temperature upon a system of reactants, both in the absence of a catalyst and in the presence of a catalyst.

On the reactants the effect of heat is twofold: (1) the kinetic activity of the particles, as units, is increased; and (2) their internal activity is also increased, that is, their electrons rotate more rapidly and probably move to exterior quantum positions. Practically, the particles move more rapidly, and they swell. As a consequence, their fields may change both in strength and in location. Bonds heretofore potent may become weakened, and bonds previously impossible may be formed. The increased kinetic activity of the particle as a unit results in an increased probability of actual *number* of encounters, but beyond a certain temperature limit, which should vary in each case, the number of encounters *which are successful* will diminish. These considerations apply equally to the meeting of the fixed particle with the active catalyst area, and to the union of the particle so bound with the other reactant.

Catalysts are similarly affected by increase of temperature. Catalyst surfaces may develop effective areas not previously present, and, if finely dispersed, the catalyst will show increased kinetic or Brownian motion, which means increased probability of successful encounters. Too high a temperature may melt or cause surface flow and ruin the catalyst. Increased pressure would, in most cases, speed combination, because of increased concentration of molecules. Besides, pressure favors closer approach. When the effect of temperature on reactants and on catalyst weakens the fields, or increases velocity so that combination is no longer possible or sufficiently lasting, then the increase in number of encounters will cease to register an effect in producing increase in *successful* combination. That is, each system of reactants and catalysts will show a thermal optimum for combination.

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MERCURY AND AMMONIA VAPOR AN EXPLOSION HAZARD

IN a small manufacturing process, strong aqueous ammonia was elevated through piping into a reaction tank, using the carboy containing the ammonia as a montejus operated by compressed air from the shop lines. In order to guard against excessive pressures in the carboy a safety-valve consisting of mercury in a U-tube was used. This was connected with the carboy by about six feet of iron pipe. The U-tube was also of iron—standard 3/4″ wrought iron pipe bent to the required form. Enough mercury was used to

limit the pressure approximately to that of a four inch column of the fluid.

This arrangement had been in daily service for ten years. A new charge of mercury was last put in about one year ago.

During the night of November 19th a violent explosion occurred, fortunately limited to a small area at the surface of the mercury on the ammonia side of the U. The 3/16″ iron of the pipe was opened out at this point over an area of about four square inches and a piece about one inch square was driven out with great force. There was no damage or evidence of high pressure elsewhere in the system.

The presence together of metallic mercury and ammonia vapor is not recorded as an explosion hazard, and the ten-year record of the installation herein involved would appear to support this implication of safety.

It would seem that a special combination of circumstances must have existed in the present instance, but a search of the literature has given no positive indication as to what these might have been. There is, however, a suggestion.

Several violently explosive compounds of mercury with nitrogen are known. Mercury fulminate is one of the more stable of these. Among the less stable are recorded certain compounds of mercuric oxide and ammonia, some of which are formed by union of the gas with the solid, but none, reputedly, at temperatures below 100° C. These compounds, however, come nearer to what might conceivably have been formed in the present instance than any others. If we assume that (1) the mercury had a layer of mercuric oxide on its inner surface and that (2) the explosive mercuri-ammonium oxides can in reality form in course of time at a temperature but slightly in excess of what we term "room" temperature, we have a good explanation of what may have happened in the case before us.

It is possible to say further only that the formation of anything more than minute traces of oxide is at least improbable here, and that, as before stated, there is no record of the combination taking place at any but much higher temperatures than could have been reached in this installation.

It remains, however, almost beyond a doubt that a mercury-nitrogen compound was responsible for the explosion; and in the absence of any definite knowledge of the necessary contributing conditions, it would seem the part of safety to class the co-presence of ammonia, in any form, and mercury as an explosion risk.

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OBSERVATIONS ON SCORPIONS

THE life history of one of the European scorpions, *Scorpio occitanus* Lat., has been known since Fabre published the results of his investigations in his "Souvenirs." Regarding the life history of American species of scorpions, very little has been published as far as I know. Comstock states in "The Spider Book" that the scorpion does not lay eggs, while Fabre has observed that the European species does lay eggs and that it breaks the eggs and devours the shells.

The scorpion *Centruroides vittatus* Say is fairly common in northwest Arkansas. It is most frequently found on dry hillsides, where it hides under stones and similar shelter.

A study of the life history of this species was undertaken during the summer of 1925. A number of pregnant females were collected and placed in an observation cage. The first young were seen on the morning of September 5. Later, careful watch was maintained through about twenty-four hours of the day, with the result that the actual arrival of several litters of young was observed. They were fully developed in the body of the female. Each young one was born in a very thin and transparent envelope from which it freed itself in about fifteen minutes time. If the young succeeded in freeing themselves, they were assisted by the mother in getting on her back. They molted here after three to six days, and remained on her back for from five to fifteen days.

The mating dances have been observed in the American scorpion; they correspond very closely to those observed by Fabre in the European species.

Judging by the rate of growth in scorpions kept in the laboratory and by various sizes secured in the field, our scorpion probably attains maturity in three or four years.

Scorpions are easily kept in captivity if provided with water and food. They will eat small insects such as grasshoppers and roaches, but refuse caterpillars. They will also eat raw lean beef. Young scorpions feed readily upon termites, apparently in preference to anything else.

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A CONFUSION OF TERMS

As shown in the discussion which follows, there is a confusion as to the meaning of the terms *dialyze, dialyzable* and *dialyzate.* Does the substance which passes through a semi-permeable membrane *dialyze,* and is it therefore *dialyzable?* Is the *dialyzate* the material which passes through the membrane or is it the material which remains in the dialyzer? Different authorities and usages do not agree.

All of the dictionaries consulted[1] agree that to dialyze a material means to subject it to the process commonly known as dialysis. In addition, Webster gives as one of the definitions of dialyze "to pass through a suitable membrane." Since dialyze comes from the Greek δια, through and λύειν, to loosen or to release, this latter meaning is in accord with the etymology of the word. It is also in accord with British and American usage.[2]

The dictionaries consulted also agree substantially that dialyzable means "capable of separation by dialysis." An adjective with this meaning is useless because it may be applied either to substances which are in "true" solution or to colloidal materials, since each may be separated from the other by dialysis. Webster, by implication only, includes in the definition of dialyzable the ability to pass through a membrane. This meaning, which is not specifically mentioned in the dictionaries cited, is the only one which is justified. It, too, is in accord with present usage[2] though there is some confusion.

The greatest contradiction exists in the definitions of dialyzate. Webster inconsistently defines the dialyzate as the material "which fails to pass through the membrane." Murray defines dialyzate as "that portion which remains after dialysis." The term *diffusate* is mentioned by these authorities as applied to the material which passes through a membrane, as opposed to the dialyzate which fails to pass through. In opposition to this view Funk and Wagnalls define dialysate "1. The compound that is to be dialyzed. 2. The crystallizable constituents of a drug freed from colloids by dialysis."

It is obvious that the word in order to be useful must designate either the material which passes through, or the material which remains in the dialyzer, and not both. From the standpoint of etymology it seems plain that the material which passes through the membrane dialyzes, is dialyzable and is therefore the dialyzate. Though the terms dialyzate and diffusate were formerly used in the sense indicated by Murray and Webster, the better usage should be unanimously adopted, whereby the term dialyzate is used to designate the material which passes through, rather than that which remains in the dialyzer. The material which remains in the dialyzer may be designated as the undialyzable residue. The word *diffusate* has no longer any use in this connection.

ROGER J. WILLIAMS

[1] Webster's New International Dictionary; Funk and Wagnalls' New Standard Dictionary; Murray's New English Dictionary.

[2] See for example Harden's "Alcoholic Fermentation," p. 57 (Longmans Green and Co.), and Mathews "Physiological Chemistry." Fourth edition, p. 393. (William Wood and Co.)

THE EDWARD CURTIS FRANKLIN FELLOWSHIP

ONE of the most distinguished and best-loved of American teachers and scholars of chemistry, Professor Edward Curtis Franklin, of Stanford University, will retire from active university service at the end of the present academic year. His students, associates and friends wish to mark this occasion by a special and enduring expression of their admiration of his achievements in chemical research and of their affection for him as teacher and friend. To this end they propose to establish an ever-living memorial to him in the form of a modestly endowed research fellowship in chemistry at Stanford University. A committee of about thirty well-known chemists and a few other friends, with Dr. Ira Remsen as honorary chairman, has been formed to collect a fund of $15,000 for this purpose. This committee is now appealing for contributions to this fund, and hopes to find general approval and support of its plan.

Franklin's career as a devoted and brilliant investigator and an inspiring teacher is well known to American chemists. He was graduated from the University of Kansas in 1888; was a student in the University of Berlin in 1890–1891; and completed his work for the doctorate under Remsen at Johns Hopkins in 1894. He began his professional work as assistant in the University of Kansas, becoming professor in 1899. He continued in this position until 1903, when he went to Stanford as associate professor. He became full professor there in 1906 and has held this position ever since.

In 1911–1913 he was chief of the division of chemistry of the U. S. Public Health Service, on leave of absence from Stanford. During the war years, 1917–1918, he was a member of the Advisory Board of the U. S. Bureau of Mines, physical chemist of the U. S. Bureau of Standards, and consulting chemist of the Ordnance Bureau of the Army. He received the honorary degree of Sc.D. from Northwestern University in 1923 and from Western Reserve in 1926. He is a member of the National Academy of Sciences and the American Philosophical Society, and was president of the American Chemical Society in 1923. In 1925 he was awarded the Nichols medal.

We provide memorials of many kinds to many men for many forms of public service. But we all too rarely express in concrete form the appreciation of our debt to such men as Franklin. The quiet, persistent and utterly devoted work of research in pure science carried on by these men is too usually overlooked by the nation and its contribution to the pub-

lic welfare too little recognized. The proposed memorial to Franklin is not to be a passive one of stone or bronze, but an active, animate one. It is to be one which will enable the fruits of his work to be plucked every year. It is the kind of memorial which he would best like.

Contributions to this memorial of any size, from the least to the largest, will be equally welcome. They should be made payable to the E. C. Franklin Fellowship Fund and sent to Professor W. H. Sloan, Stanford University P. O., California.

Vernon Kellogg
National Research Council

SCIENTIFIC BOOKS

A Review of the Giant Mackerel-like Fishes, Tunnies, Spearfishes and Swordfishes. With twenty plates. By David Starr Jordan and Barton Warren Evermann. California Academy of Sciences, San Francisco. 1926.

Dr. Jordan and Dr. Evermann have lately issued a memoir of interest to naturalists generally, and especially to anglers for tuna, swordfish and others of their kind, which abound at the surface in deep seas of certain favored regions. These fishes, the choicest prizes of oceanic anglers, are of many species, representing six different types, the tunas or tunnies, the albacores, the swordfish, the marlin fishes, the spearfishes and the sailfishes. These fishes are all too large for museum purposes, one of the marlins reaching a weight of 1,400 pounds. But few mounted examples or casts are in existence, these expensive and of very recent date. Hence careful studies of the species have been almost impossible. The authors of this book have examined many fresh examples in the markets of Japan and Hawaii, and among angler's trophies at Santa Catalina, but have been compelled to depend chiefly on photographs. The work in regard to distinction of species is therefore mostly tentative, but it is sufficiently detailed to show that the nomenclature hitherto accepted is mostly incorrect and nearly worthless. Except the cosmopolitan swordfish (*Xiphias gladius*) no species seems to be common to the Atlantic and Pacific, and the tropical species do not run much north of the Tropic of Cancer, those north of that line being mostly different from those found southward.

These "giant mackerels" belong to three distinct families, the Tunnies or Tunas (*Thunnidae*) with five genera, *Thunnus, Germo* (Albacore), *Parathunnus, Neothunnus* (yellow fin) and *Kishinoëlla.* The species of *Thunnus* reach 600 to 800 pounds in weight, those of the dwarf Albacore, *Kishinoëlla,* only 20 pounds.

The famous "leaping tuna" of the Santa Barbara Islands is given a new name (with some doubt), *Thunnus saliens.*

The *Istiophoridæ,* sailfishes and their relatives, have a long sharp sword, like the swordfishes, but it is slenderer and the groups differ otherwise in fins, scales and character of flesh. In this family are three well-marked genera, differing in the form of the dorsal fin. Of these, *Makaira,* with the front only of the dorsal elevated, is largest in size of individuals and most numerous in species. In the Pacific these are called marlins or marlin-spike fishes. Different species of this type are found in all warm seas.

Tetrapturus (spearfishes) has the dorsal fin of moderate and nearly uniform height throughout. No species occurs in America.

Istiophorus (sailfishes) has the dorsal fin inordinately high, bright blue with small black spots. Its species, all tropical, are perhaps swiftest of all fishes, abounding off Florida, Cape San Lucas and Southern Japan. The commonest forms are *Istiophorus volador* of the Atlantic and *Istiophorus greyi* of the eastern Pacific.

The *Xiphiidae* or swordfishes have but one species, *Xiphias gladius,* found all the world over except in the Arctic. The largest on record weighed 572 pounds.

In this memoir good illustrations are given of all the species not figured elsewhere.

The species found off our Atlantic Coast and in the West Indies are the following:

Thunnus secundodorsalis Thunnus coretta Thunnus subulatus	All these perhaps the same as *Thunnus thynnus* of Europe.
Germo alalunga	
Parathunnus obesus	
Neothunnus albacores Neothunnus allisoni	Perhaps the same.
Neothunnus albacora	
Makaira albida	
Makaira ampla	
Istiophorus americanus	
Istiophorus volador	
Istiophorus maguirei (perhaps young of I. volador)	
Isthiophorus wrighti.	

C. H. Gilbert
Stanford University

SCIENTIFIC APPARATUS AND LABORATORY METHODS

AN IMPROVED CLOSING BOTTLE FOR SUB-SURFACE SAMPLING OF FLUIDS

Ever since my experience in plankton collecting in the San Joaquin River, 1912–1915, I have been

strongly impressed with the need for a closing bottle (or bucket) with three qualifications not found in any model about which I had knowledge. These qualifications are: low cost, simple construction and operation and light weight. About three years ago I drew up a rough outline of a design which I thought might prove satisfactory.[1] Several months later I succeeded in getting the interest of the Braun Corporation (of Los Angeles) in the matter, and Mr. O. C. Beach, second vice-president in charge of their factory division, drew plans to cover technical details.

After some discussion of these plans by members of the scientific staff of the Scripps Institution it was finally decided by Director T. Wayland Vaughan to place an order for a trial model. This trial model has now been in more or less frequent use by the Scripps Institution for more than a year, and it has yielded some excellent results.

The most striking success has been in the boat work of the past summer (1926), in which more than forty series of subsurface catches at five meter intervals have been made, without a break in any series. This is the best record ever attained by this institution. The record is made still more impressive by consideration of the fact that two separate hauls were taken at each level, and combined, to constitute the catch. Two hauls at each level were made because of the small capacity of the trial model (five liters) which was kept small enough for use in a rowboat, without hoisting equipment. A ten liter capacity is preferable for plankton work where good hoisting equipment is available.

The fundamental features of the bottle are two in number, first, a cylinder for container, second, a sliding rod at the axis of the cylinder with plates (valves) attached at a distance apart suitable for closing the cylinder when the rod is pulled through to the correct position. Practically, there are several additional parts, notably a spider at each end of the cylinder to support and guide the valve rod, each spider set on an internal flange which gives an accurate, watertight seat for the valves. There are also suitable arrangements for attaching line or cable, and for drainage.

The bottle is sent down open, with the cable attached to the outer rim of the cylinder, so that the weight of the valves causes them to drop below their seats. A messenger sent down to a Nansen trip (or other releasing device) causes detachment at this point and the weight is thrown on to the valve rod, the upper end of which is attached to the cable. The weight of the cylinder brings the valve seats down to the valves, which then remain closed by its weight, or by a special holding device.

The simplicity of design is such that it seems certain that the shape and size of the bottle can be varied within rather wide limits for specific purposes. Thus, it might in one case be given the form of a long tube, or in another case it might be made up as a short, broad cylinder.

It is also probable that different materials could be used for manufacture, *e.g.*, pyrex, or other durable glass. For ordinary collecting of marine plankton diatoms brass is a satisfactory material. The trial model now in use (and an improved model in preparation) is constructed entirely of metal and the valves are so accurately seated that there is no leakage after months of usage. On this account it has recently been used for collecting samples for chemical analysis as well as for collecting phyto-plankton.

If insulation should be desired it could undoubtedly be provided at the time of manufacture at a material increase in cost.

For operation from a boat where there is considerable rolling and pitching Dr. E. G. Moberg, who has charge of boat work for the Scripps Institution, has been accustomed to use a stabilizer consisting of a window weight suspended from the bottom of the bottle by about fifty feet of line. Dr. Moberg and Mr. James Ross, mechanician, have also contributed valuable suggestions concerning certain details of construction of the bottle.

WINFRED EMORY ALLEN

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[1] Dr. E. G. Moberg afterward called my attention to the fact that Milne's modification of Meyer's bottle has the same fundamental method of construction. Milne's model was successfully used for some special work of the *Challenger Expedition*.

SPECIAL ARTICLES

THE WIDTH OF THE BASILAR MEMBRANE

DATA upon both the actual and the relative dimensions of the basilar membrane are of fundamental importance in all considerations of possible functional performance. The measurements which I have made of the widths of the basilar membrane in the guinea pig (Cavia cobaya) have shown it to differ so essentially from the usual description for mammalia that it seems desirable to make a brief report in a journal which will reach the attention of the workers in the several fields of science who are concerned with the problems of hearing. A full report will be made later in one of the anatomical journals.

In the numerous works on theories of hearing in which some type of movement of the basilar mem-

brane has been postulated this membrane has been regarded as always and continuously increasing in width from basal to apical ends. Many have gone so far as to use diagrams showing a uniformly rapid increase and have even constructed "models" on this assumption. The original data on which this usual conception of the basilar membrane are based are very meager, indeed, and none of them gives actual support to the idea of a uniform rate of increase in width. As an illustration of the insufficiency of the data is the fact that the very much quoted widths given by Retzius for the human in his great classic are the measurements for a single labyrinth only, and there is no way given of even estimating the linear distance between the three places measured. In all the previous data of which I am aware the nearer the apex of the cochlea the greater is the width of the basilar membrane; in almost all a single labyrinth only has been measured for each species; and for no species has a sufficient number of individuals been measured to give any idea of the range of variation. (Citations of literature will be given in the detailed report of this work.)

Good mid-modiolar orientation and good histologic preservation have been the criteria used in choosing from my collection the thirty-five series of sections of the labyrinth of the guinea pig in which I have measured the width of the basilar membrane. The histologic technique was identical in all, so that the effect of this was similar, at least. The measurements of all parts except the basal end (vestibular part) have been made for each membrane on the several parts included in a single section selected from each series as the nearest to the middle of the modiolar axis. Since in the guinea pig the cochlea has somewhat more than four full turns such a section strikes it in eight places. I have measured with a screw micrometer ocular and suitable objective the distance from the attachment of the basilar membrane at the edge of the spiral lamina (some have measured from the foramina nervosa) to its attachment to the spiral ligament; these are listed in the tables under the respective half-turns. The "lowest" end of the basilar membrane was measured in whatever section of the series it was located; the membrane under the "lowest" place where a distinct organ of Corti is present has been selected for the measurement of this narrow end of the vestibular part, and since the direction of this section is not "radial" the figures for this narrow end are doubtless all too large. These are the values listed under the heading "P.v." in the tables.

By means of the graphic reconstruction method (Guild, *Anat. Record,* Vol. 22) the lengths of each half-turn were determined for three cochleae, and from the averages of these three values a rough approximation has been made of the average distance between the places at which the widths were measured. The parts included in the horizontally oriented mid-modiolar sections used are about in the middle of their respective half-turns. By combining the width and length data a value is obtained for the "rate of change" in width in the various parts. While these values are not very accurate the differences are so great that they must at least indicate the order of the values for the several parts; and this is something which no previous work has attempted for any form. This rate of change has been expressed as a fraction with the denominator the number of units lengthwise of the basilar membrane required for a change of one unit in width. In the tables these fractions are placed on an intermediate level between the width measurements concerned. The plus and minus signs indicate respectively that the change is an increase or a decrease in width in the apical direction. Thus, in Table 1, the fraction "+1/77" means that between the middle of the first half-turn and the middle of the second half-turn there is on the average an increase in width of the basilar membrane of one unit for each seventy-seven units of length.

The guinea pigs used ranged in weight from 175 to 350 grams; age data were not available. Individual variations between the dimensions in animals of the same weight are so great as to render insignificant any possible growth effect which might be based

TABLE 1

Widths in Microns of Basilar Membrane in Guinea Pigs

Half-turn	Minimum	Maximum	Average of 35	Av. rate of change
P.v.	49	73	62.3	
				+1/49
1st	124	143	131.6	
				+1/77
2nd	161	181	173.3	
				+1/519
3rd	160	188	178.3	
				+1/112
4th	180	206	196.6	
				+1/525
5th	181	217	200.0	
				+1/175
6th	194	227	209.1	
				=0
7th	192	228	209.3	
				−1/56
8th	169	219	189.4	

on this series. For example, it may be mentioned that the weights of animals 1, 2 and 3 of Table 2 were, respectively, 350, 320 and 340 grams.

The greatest width of the basilar membrane is located on the average in these thirty-five guinea pigs nearly a full turn below the apical end, which is always distinctly narrower than the widest part, and in fact is decreasing in width almost as rapidly as the basal end increases. Other points of particular interest in connection with functional theories are the great range of the actual and the relative widths in individuals (very noticeable upon inspection of the whole group of measurements); the wide departure from anything like a uniform rate of increase in width; and especially interesting is the fact that the width at the third half-turn and at the fifth half-turn is frequently less than or only equal to that of the half-turn below, while in many, although not in all, of the other individuals the rate of increase in width in these two regions is much less than in other parts. Thus for the guinea pig the usual description of width changes of the basilar membrane in mammalia must be completely revised, and may be briefly summarized as follows. Proceeding apicalward from a narrow basal end there is a relatively rapid increase in width which becomes less rapid toward the upper part of the basal turn and between the second and third half-turns the average increase is very slight and there may even be a zone of constant or of slowly decreasing width; above this is another region of more rapid increase in width for about a half-turn, followed by a second zone of slowly increasing or even of constant or slowly decreasing width as the middle of the fifth half-turn is approached; above this the membrane again increases definitely in width until a rather elongated part of greatest width is reached in the upper part of the third and lower part of the apical coils; above this widest zone there is always a rapid decrease in width as the apex is approached.

TABLE 2

EXAMPLES OF THE INDIVIDUAL VARIATIONS IN BASILAR MEMBRANES OF GUINEA PIGS

Half-turn	Animal 1		Animal 2		Animal 3	
	Width	Rate of change	Width	Rate of change	Width	Rate of change
P.v.	56		57		69	
		+1/44		+1/52		+1/46
1st	127		124		143	
		+1/61		+1/86		+1/107
2nd	177		161		173	
		−1/504		+1/196		+1/216
3rd	172		174		185	
		+1/78		+1/128		+1/107
4th	197		190		204	
		+1/425		−1/200		+1/357
5th	201		181		209	
		+1/167		+1/127		+1/123
6th	210		194		222	
		−1/665		+1/359		+1/1408
7th	208		198		223	
		−1/107		−1/66		−1/27
8th	198		180		182	

The fundamental bearing of such data upon possible functional performance is apparent at once to all who are familiar with the theories of hearing which have been based upon hypothetical movements of the basilar membrane. Since neither for the human nor for any other form has a sufficient number of labyrinths been measured it is of course impossible as yet to say whether or not the guinea pig is an exception or whether more data upon the other forms will disprove for them also the present descriptions. The guinea pig has been the most used animal in the sound injury experimental work and for this reason alone, if for no other, it is of importance to know whether it does differ sufficiently from other forms in this respect as to essentially affect the value of the conclusions drawn from these objective experiments.

It is of course well recognized that the width of the membrane itself is only one factor of the several that must influence the hypothetical responses of the basilar membrane to sound waves, and it may be that variations in width in an individual are compensated for by combinations of variations in the other factors. But of these other factors we have as yet an even more incomplete record than of the width of the basilar membrane. In my opinion the need at present for a better foundation of morphologic facts is much greater than for more theorizing on the problem of hearing.

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EXCYSTATION IN IODAMOEBA WILLIAMSI IN VIVO AND IN VITRO

IODAMOEBA WILLIAMSI is a human intestinal amoeba that apparently occurs in about 10 per cent. of the general population. Two stages are known in its life cycle, an active stage, the trophozoite, and a passive stage, the cyst. Infection of new hosts is supposed to be brought about by the ingestion of cysts which excyst in the human intestine. So far as is known, excystation in this species has never been reported.

Excystation in vivo: Washed cysts were inoculated into the stomach of guinea pigs and the animals sacri-

ficed at intervals of one, three, four and six hours. Excysted specimens were observed at the end of three hours in the jejunum and ileum, and at the end of four and six hours in the ileum and caecum. These observations prove that the factors necessary for the excystation of *Iodamoeba williamsi* are present in the digestive tract of the guinea pig and that excystation may occur at least by the time the cysts reach the jejunum and within a period of three hours. No excystation was observed within one hour after cysts were introduced into the stomach of the experimental animals. The fact that a number of guinea pigs, including young amoebae-free specimens, that were fed repeated doses of viable cysts, did not become infected, indicates that the excysted amoebae are ordinarily unable to set up an infection in this animal. This is due, probably, to factors that render the medium within the guinea pig intestine unfavorable for their growth and reproduction.

Excystation in vitro: The method of escape of *Iodamoeba williamsi* from the enveloping cyst wall can be brought about under a cover glass by supplying the proper stimuli, and has been observed by the writer many times. Material containing washed cysts was diluted with physiological saline solution and sealed under a cover glass. Slides prepared in this way, containing cysts that had been passed about fifteen hours previously, were placed in an incubator at 37° C. for two hours, and then removed to a warm stage. Usually about three hours later some of the cysts were observed to be undergoing excystation. Small, irregular spaces appeared between the protoplasm and the cyst wall. Movement within the cyst consisted of the formation of minute pseudopodia. One of these would eventually find its way through the cyst wall, whether *via* a pore or an opening due to the activity of the amoeba was not determined. Sometimes this pseudopodium would be followed by the gradual emergence of the entire animal; in some cases, however, a partly extruded animal would return within the cyst, and, after a brief period, would again attempt to make its escape from the cyst wall, finally succeeding. The excysted amoeba is much more active than descriptions of the trophozoite of this species would lead one to expect. Pseudopodia were thrown out constantly; in one case, for at least forty minutes.

From these studies it is evident that the stimuli necessary for excystation are moisture and a suitable temperature for a certain period. The required temperature seems to be about 37° C., and the time that the cysts must remain at this temperature about five hours.

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THE PHOTOGRAPHIC STUDY OF THE INFRA-RED SPECTRUM OF MERCURY[1]

IN a previous work in 1922 the author attempted to photograph the infra-red spectrum of mercury with dicyanine stained plates and a prism instrument. The success was limited to the detection beyond $\lambda = 8{,}200$ A.U. of only the wave-length $\lambda = 10{,}141$ A.U. The discovery of a new sensitizer neocyanine by the Eastman Research Laboratory revived hopes for a more successful investigation. Using, as before, a Hilger constant deviation spectrograph, the mercury spectrum was photographed a number of times. The results of the present investigation in general are in good agreement with those of previous authors in the region below wave-length $\lambda = 8{,}200$ A.U. Above this wave-length the present work is entirely in conflict with a photographic study recorded in the literature, although it verifies the radiometrically detected lines. The plates revealed the existence of nineteen lines between $\lambda = 8{,}196$ A.U. and $\lambda = 13{,}670$ A.U. Nine of the lines of wave lengths, 10,141, 10,363, 10,765, 10,920, 11,288, 11,887, 12,850, 13,572, 13,670 A.U. were registered previously by means of various radiometric devices, the other ten of wave lengths 8,291, 8,443, 8,520, 8,704, 8,788, 9,012, 9,053, 9,258, 9,499, 10,243 appear to be detected for the first time. Beyond the last line measured $\lambda = 13{,}670$ A.U. four more lines were photographed. The means in the author's possession were not sufficient to determine the wave-lengths of these lines. The application of Canchy's formula leads to a very startling result for the last line in the neighborhood of 27,000 A.U.

The line $\lambda = 10{,}141$ A.U. presents a special interest. This line was first detected radiometrically by Paschen and was described as a single sharp line. Later it was suggested that it might be a double line with a separation of about 35 to 40 A.U. between the components. The present work corroborates the original observation of Paschen that it is a single, very strong line and of the wave-length as given by Paschen. The ease with which the line $\lambda = 10{,}141$ A.U. could be photographed in the present work suggested the study of the absorption of line $\lambda = 10{,}141$ A.U. by non-luminous vapor of mercury. In this respect the investigation corroborates later data in the conclusion that strong absorption of this line is out of the question.

A more detailed account of this work is soon to appear elsewhere, and the complete paper will be published in the University of Colorado Studies.

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[1] Preliminary note of the dissertation accepted by the faculty of the Graduate School of the University of Colorado in partial fulfilment of the requirements for the degree of doctor of philosophy.